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This document is one of a series of technical reports published by the Ministry of Water Resources addressing issues relevant to strategic planning for the sustainable use of the water and land resources of Iraq.

The technical report relates to the provision of water for household, industrial, commercial, institutional and other uses within the towns and villages of Iraq.

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Preliminary

1 Introduction

1.1 Purpose of Document

- 1.1.1 This document relates to the provision of water for household, industrial, commercial, institutional and other uses within the towns and villages of Iraq. It generally considers potable water supplies, i.e. those treated to a level to make them suitable for human consumption, although only a very small percentage of such water is actually consumed. Consideration is also given to non potable water used for industrial purposes and the non potable piped water supply system in Baghdad, which provides water primarily for garden watering.
- 1.1.2 In the context of the current project, the studies on potable water supplies are largely limited to assessing the demand for water and establishing abstractions from and returns to the natural water environment.

1.2 Format of Document

- 1.2.1 The document is structured as follows:

- Section 2 Review of data availability
- Section 3 Water supply and demand in Iraq
- Section 4 Water balances
- Section 5 Investment planning (*Not completed*)

2 Review of Available Data

2.1 Population

2.1.1 We have population and housing data from the Ministry of Planning which includes the following:

- Total population for years 1957, 1965 and 1970 to 2004
- Population broken down into total urban and total rural for each governorate for 1997 and 2004
- Numbers of housing units and households broken down into urban and rural for 1997
- Numbers of housing units and households for each governorate for 1997.

2.1.2 Historic data indicates a past growth rate of about 3% per annum. Growth appears to have been fairly uniform. This rate of growth is used by the Ministry of Municipalities and Public Works to project future populations. The mini Master Plan for Basrah indicates that the Ministry of Planning projects future populations at a growth rate of 2.25% per annum to 2010 and 2.0% per annum thereafter.

2.2 Existing Municipal Water Supplies

Data from the Ministry of Municipalities and Public Works

2.2.1 The Ministry of Municipalities and Public Works (MMPW) has provided a list of water treatment plants, wells and compact units for 15 governorates. There is no data for the three Kurdish governorates of Dahuk, Erbil and Sulaymaniyah. Data for each facility include location given by coordinates, planned output, actual output and numbers of people served.

2.2.2 We understand that the list is probably far from complete, although it is believed to be the most comprehensive list available. There is a reasonable correlation between the number of water treatment plants in the list and those recorded in specific plans for individual governorates, but the number of compact units (CUs) varies widely. We understand that CUs are put in by various organisations without any real coordination or record keeping

2.2.3 A weakness of the MMPW list is that it does not indicate which town(s) each treatment plant serves, nor the source of water for each works. There are coordinates for the location of each works, but these are unreliable, and in any case the treatment plant does not necessarily serve the area in which it is located, or the source of raw water may be far from the works.

2.2.4 Analysis of per capita consumption (pcc) from data for outputs and people served in the MMPW list shows a very wide range with many anomalous figures, e.g.

- For water treatment plants, the calculated pcc varies from 24 to over 10,000 litres per person per day (lpcd)
- The variation is even more extreme for CUs
- In 8 governorates (over half for which data are supplied) the average pcc is 333 lpcd for all works. The governorates with this figure throughout are Al Anbar, Baghdad, Basrah, Diyala, Maysan, Muthanna, Qadisiyah and Salah al Din. We assume that 333 is a target figure for supply and population served is calculated from measured/estimated works output or actual output is calculated backwards from population served.

Mini Master Plans

2.2.5 Water supply mini master plans have been or are being prepared for the governorates of Basrah, Erbil and Sulaymaniyah and copies have been provided. A wastewater plan has been prepared for Karbala and copy of that has also been provided. Further plans are due to be completed for water supplies to, Najaf, Diwania and Kirkuk.

2.2.6 Despite their name, these plans appear quite comprehensive, although their coverage varies. That for Basrah covers the whole governorate with the focus on the municipality of Basrah, whilst those for Erbil and Sulaymaniyah cover the governorate except for the main towns of Erbil of Sulaymaniyah. The wastewater mini master plan for Karbala is only for the main town.

2.2.7 A very brief outline of the planning criteria used and water requirements for each plan is given below.

(i) Basrah

2.2.8 The basic demand criteria used for Basrah were as shown below.

Table 2-1: Planning Criteria for Basrah Demand Forecast

Location	Level of Service Factors (l/c/d)				
	Domestic	Commercial	Industrial	UfW	Total
Basrah	300	30	30	72	432
Towns with industry	200	30	30	52	312
Towns without industry	200	30		46	276
Rural	200			40	240

2.2.9 There is no indication whether these figures are average or peak daily demands. It is assumed that they are peak figures as they are used to establish capacity requirements.

2.2.10 The population of the governorate is projected to rise from 1,761,000 in 2003 to 3,375,000 in 2025, using a growth rate of 3% per annum in line with that used by MMPW. Applying the above figures for per capita water demands to the projected population gives a present total peak daily water demand of about 650,000 m³/d rising to 1,167,400 m³/d by 2025.

2.2.11 The mini master plan examined seven options for meeting this demand and recommended a combination of conventional treatment of water from the River Tigris at Al Quorna and desalination of water from the Shat al Arab in Basrah. It is proposed that normally 40% of the water will come from Al Qorna and 60% from the Shat al Arab. The different supplies will be blended to give a potable supply meeting Iraqi and WHO guidelines.

(ii) Erbil

2.2.12 The population of Erbil is expected to grow from its current level of about 1,600,000 to 2,900,000 by 2025. This is a growth rate of 3% per annum. The urban centres, outside the city of Erbil itself, have a present population of about 250,000 and this is projected to rise to 437,520 by 2025.

2.2.13 The overall per capita demand for people in the district centres is taken to be between 360 and 390 l/d and applying these figures to the population forecast gives a total demand rising to 160,216 m³/d by 2025. The total demand from sub-district centres is forecast to be 52,861 m³/d by 2025. No water demand figures are given

for rural areas, although it is noted that about 28% of the total population of the governorate are classified as rural.

- 2.2.14 Proposals for development of water supplies generally anticipate increases in abstractions from existing local sources, which are a mixture of springs, rivers and groundwater.

(iii) Sulaymaniyah

- 2.2.15 The population of Sulaymaniyah is expected to grow from its current level of about 1,800,000 to 3,300,000 by 2025. This is a growth rate of 3% per annum. The urban centres, outside the city of Sulaymaniyah itself, have a present population of about 257,000 and this is projected to rise to 464,171 by 2025.

- 2.2.16 The overall per capita demand for people in the district centres is taken to be 360 l/d and applying this figure to the population forecast gives a total demand rising to 167,101 m³/d by 2025. The total demand from sub-district centres is forecast to be 521,972 m³/d by 2025. No water demand figures are given for rural areas, although it is noted that about 20% of the total population of the governorate are classified as rural.

- 2.2.17 Proposals for development of water supplies generally anticipate various new surface water and groundwater sources. Sources will generally be local to the communities supplied.

New Eden Project

- 2.2.18 The reports provide data on existing systems and estimates for the development of water and sanitation systems. Although costs are given, there are no projections of water demand or lists of schemes in the main report.

- 2.2.19 The criteria for water demand assessment are given in the report as follows:

Governorate headquarters	450 lpcd
District capitals	360 lpcd
Rural communities	250 lpcd

- 2.2.20 These are similar to those used in the mini master plans and were agreed with MMPW. They are assumed to overall peak day demands, including an allowance for unaccounted for water (UfW).

Information from the Reconstruction Project in Southern Iraq

2.2.21 As part of its work on the reconstruction project in Southern Iraq, Mott MacDonald has worked on water sanitation projects in Basrah, Thi Qar, Al Muthanna and Maysan governorates. As part of this work, outline plans were prepared for the development of water and sanitation systems in these four governorates in 2004.

2.2.22 The figures in the table below were used as an initial guideline for assessing water requirements and the adequacy of existing systems.

Table 2-2: Suggested Long Term Planning Criteria

Item	Per capita water demand (l/day)	
	Urban areas with developed internal plumbing systems	Rural areas with limited internal plumbing systems
Household demand	160	120
Non-household demand (industry, commerce, institutions, etc.)	40	20
Total consumption	200	140
Unaccounted for water	67	47
Total water requirement (average day)	267	187
Total water requirement (peak summer day)	335	237

2.2.23 The figures in the above table assume unaccounted for water is 25% of water production, which is a reasonable, but certainly not demanding target. The average per capita household consumption assumes a reasonably careful use of water and is based the normal requirements for household use. The figures used are also similar to figures which Mott MacDonald has recently used for a master plan for Oman. The summer peak assumes a 40% increase in average household demand, reflecting the extremes in temperature, and a 10% increase in non-household demand.

Analysis of Data

2.2.24 The following table summarises the data in the MMPW lists for 15 governorates and provides comparisons with data from other sources.

Table 2-3: Summary of Data on Existing Water Supplies

Governorate	Actual capacity from MMPW list (m3/d)				Population 2004	Capacity per person (l/d)	Capacities from other sources (m3/d)		
	WTP	Well	CU	Total			New Eden	Mini MP	MM 2004
Al Anbar	326,561		96,240	422,801	1,328,776	318			
Babil	71,760		26,256	98,016	1,493,718	66			
Baghdad	235,591		113,460	349,051	6,554,126	407			
Baghdad municipality	2,208,000		113,000	2,321,000					
Basrah	476,206		371,540	847,746	1,797,821	472	850,000	555,600	n/a
Diyala	308,465		65,050	373,515	1,418,455	263			
Karbala	215,270		30,720	245,990	787,072	313			
Al Tamim (Kirkuk)	383,140	7,000	30,840	420,980	854,470	493			
Maysan	56,314		89,640	145,954	762,872	191	271,656		197,000
Al Muthanna	83,138		16,920	100,058	554,994	180			86,000
Najaf	257,300		21,140	278,440	978,400	285			
Ninawah	603,217	22,059	62,068	687,344	2,554,270	269			
Qadisiyah	210,352		39,185	249,537	911,641	274			
Salah al Din	228,930		54,060	282,990	1,119,369	253			
Thi Qar	108,340		116,832	225,172	1,472,405	153	308,000		129,000
Wasit	174,300		52,794	227,094	971,280	234			
Total	5,946,884	29,059	1,299,745	7,275,688	23,559,669	309			

Notes:

- 1 Population data from Ministry of Planning figures
- 2 New Eden: new Eden Master plan for Integrated Water resources Management in the Marshlands Area, April 2006
- 3 Mini MP: Drinking Water Supply Mini Master Plan, CH2M Hill/Parsons, 2005.
- 4 MM 2004: Data from Mott Macdonald's outline plans for the four southern provinces, 2004.

- 2.2.25 Although only limited comparisons between different data sources are available, it is clear that there are wide differences in several places where such comparisons are possible. The New Eden Project generally gives significantly higher figures than the MMPW list, whilst the Basrah Mini Master Plan and the Mott MacDonald data from 2004 appear generally to give low figures.
- 2.2.26 In some cases, the differences may be due to the coverage of the reports e.g. Mott MacDonald's work was focussed only on the main towns. Another possible source of error is the number of operating hours assumed each day. The data in the New Eden Project reports is given in m³/hour, and the figures in the table above assume 24 hours per day operation and make no allowance for outages. We understand, however, that some works operate only in daylight hours.
- 2.2.27 The data from the MMPW list indicates that average per capita supply capacity is just over 300 lpcd, but varies widely between governorates from a low of 66 lpcd in Babil to a high of 472 in Basrah. The figures suggest that the overall supply capacity in many governorates should be adequate to maintain at least a good basic level of service to most of the population. However, reports suggest that this is rarely the case due to a variety of reasons including inequitable distribution of water, high levels of leakage, frequent loss of supply due to loss of power and reduced operating hours due to security problems.
- 2.2.28 About 18% of the total capacity is from compact units (CUs). These are prefabricated steel plants with a limited lifespan, perhaps only 10 years. The New Eden Project reports record the condition and performance of the works and many CUs are classified as 'poor' in both respects. It is likely that a major programme of replacement of these plants with more robust conventional plants will be required in the coming years.

2.3 Industrial Water Supplies

- 2.3.1 A limited amount of information has been received from the Ministry of Industry and Materials. Tabulated data collected describes each industrial water user, the source of the water, the volume used, the volume discharged and a description of the discharge location. There are 107 records, but not all have complete information. Unfortunately the list does not indicate what units are used for measurement of abstractions and discharges, nor the location of the industry, although a separate list gives longitude and latitude references for a few companies. There are several major water consumers with private supplies in the chemical, petroleum, iron & steel, sugar refining and cement industries.

2.4 Existing Wastewater Collection and Treatment Facilities

- 2.4.1 Data on wastewater systems is only available from other reports. In general, piped sewerage schemes serve district headquarters but are limited in extent and wastewater treatment plants serve only parts of the major towns and often perform

poorly if at all. Many houses have septic tanks but these are often badly maintained and rarely emptied, and much wastewater is discharged to open drains. The situation on sewage treatment in the four southern provinces has been compiled from reports on the New Eden Project and from the work of Mott MacDonald in 2004. The situation is summarised in the table below.

Table 2-4: Sewage Treatment Plants in Four Southern Governorates

Governorate/town	Capacity (PE)	Remarks
Basrah		
- Hamdan WWTP, Basrah city	400,000	Poor condition, partial treatment only
- Khur al Zubair	100,000	Not working
Thi Qar		
- Nasariyah	85,000	Not working
- Ali Askan Al Sinaie	10,000	Acceptable
Maysan		
- Amarah	150,000	Acceptable
Al Muthanna		
- Samawah	n/a	Two works dedicated to residential complexes only

2.4.2 We understand the situation in the four southern provinces is not atypical and clearly the collection treatment and disposal of wastewater in an environmentally acceptable way will require massive investment.

3 The Demand for Municipal Water and Wastewater Services

3.1 Current Levels of Consumption

- 3.1.1 There are few details of water of current water consumption by individuals or households beyond the gross output figures divided by estimates of the population served. As noted above, the calculation of per capita demand from the MMPW list of treatment plants and population served gives widely varying and anomalous results. It provides at best an overall value of the volume of water put into supply per person in the service area. It can not be broken down into water used by different categories of consumer (households, industry, commerce, institutions, etc) and unaccounted for water, which may again be sub-divided into leakage, meter error, legitimate unmetered use and illegal consumption.
- 3.1.2 Despite the lack of information on water consumption, there are indications that it may be high relative to levels in Europe and other countries where there is an emphasis on conservation of water. For example, in Amarah city the estimated output of the treatment plants, allowing for the normal maximum operating hours, is about 120,000 m³/d. The population is about 400,000, so the supply amounts to 300 lpcd. This would certainly provide a reasonable level of service is leakage is kept to an acceptable level, there are no exceptionally large non-household demands and the water is equitably distributed. Even in the remaining districts and sub-districts the supply amounts to over 200 lpcd.

3.2 Current Planning Criteria

- 3.2.1 The key planning criteria adopted by MMPW to assess demand is apparently the figure for household consumption of 300 lpcd for supplies to major cities. To this is added an allowance for non-household use and UfW, as in Table 2-1 for Basrah, to give a gross figure of 432 lpcd for Basrah city. The overall per capita demand figures of 360 to 390 lpcd used for Erbil and Sulaymaniyah district centres, and the figures of 450 lpcd and 360 lpcd used for governorate and district headquarters in the New Eden Project all appear to be broadly consistent with the figure for Basrah. In the Basrah Mini Master Plan, a household consumption of 200 lpcd was used for district towns, giving an overall of 276 to 312 lpcd.
- 3.2.2 Neither the mini master plans nor the New Eden Project include any allowance for seasonal variations in demand. Because the above figures are used to determine the capacity of water treatment plants required, we assume that they are peak daily demands.
- 3.2.3 The Basrah figures include an allowance for UfW of only 20% of demand (17% of water production). This is an optimistic assumption and a level that will be difficult to achieve with replacement of much the existing water distribution network.

- 3.2.4 The build up of the demand forecast for the four southern governorates by Mott MacDonald in 2004 started with lower basic household per capita demands, from a gross average per capita demand figure was calculated and then increased to provide a peak summer demand. The overall demand figure of 335 lpcd for urban areas is broadly similar to the gross figures for district towns in the Basrah Mini Master Plan, but rather less than figures used elsewhere. The MM 2004 demand estimate also uses a figure of 25% of water production for UfW.

3.3 Demand Management and its Potential Impacts

- 3.3.1 In formulating any demand forecast, it is essential to consider what policy is to be adopted with regard to restraining the growth of demand through various mechanisms. Demand management is important because it ensures an efficient allocation of resources. This is very important where water resources are scarce and there is competition for available supplies, but even where water is abundant, demand management minimises the investments needed in treatment and distribution to meet the demand for potable water thereby freeing financial resources for other priority projects.
- 3.3.2 The various means of restraining demand are described in the Guidance Note – Demand Management. They may be broadly divided into the following:
- 3.3.3 Short term measures to cope with droughts or other supply failures:
- Restrictions on use
 - Appeals to the public to conserve water.
- 3.3.4 Long term
- Tariff increases and tariff structures
 - Building restrictions
 - Education programmes
 - Reducing UfW.
- 3.3.5 We would not expect short term measures to deal with droughts to have a wide relevance in Iraq, although there will undoubtedly be occasions when the unexpected loss of a major treatment plant or other key installation will cause a critical loss of supply for an appreciable period.
- 3.3.6 The main focus here will be on the long term control of water demand by eliminating wasteful use. The key to demand management is setting an appropriate tariff as without this the message that water is valuable and needs to be conserved will not be readily received.
- 3.3.7 The impact of demand management varies widely depending on social factors and peoples attitudes to water use. The introduction of metering of individual consumers

and increasing tariffs to the levels needed for full cost recovery can have dramatic impacts where wages are low. It is expected that the imposition of a strict demand management policy, including setting tariffs to recover the full cost of supplies, would have a substantial impact on demand in Iraq.

3.4 Demand Forecasting

Approach

3.4.1 The approach to demand forecasting is given in the Guidance Note – Forecasting Demands for Municipal and Rural Water Supplies. The guidance note presents a simple procedure based on breaking the demand down into the following components:

- Household consumption, including consumption for both in the house and outside for car washing, yard cleaning and garden watering.
- General non-household consumption (Institutions, commercial premises, small and medium industries)
- Major industries with large water demands
- Unaccounted for water (UfW), which includes physical losses from the distribution system, legitimate unmeasured use, illegal consumption and meter error.

3.4.2 The system could be made more sophisticated as more data become available, but at present demand forecasting is likely to be limited by data availability and any forecasts must be regarded as indicative projections that will need to be updated in the future. In fact there is always an element of uncertainty in demand forecasting and the growth in demand always needs to be monitored carefully and forecasts reviewed and improved as necessary.

3.4.3 The Guidance Note also includes assessments of wastewater returns.

Per Capita Demands

3.4.4 Per capita demands have been assessed assuming that a programme of demand management is implemented. The derivation of the figures used is described in the Guidance Note. Household demand, non-household demand and Unaccounted for Water have all been expressed in litres per capita per day (lpcd).

3.4.5 The figures are summarised in the table below.

3.4.6 It is emphasised that these are broad assessments of a reasonable level of demand and need to be re-assessed for individual schemes. They provide a reasonable basis for a preliminary assessment of demands and the investments that will be needed in water supply and wastewater systems.

Table 3-1: Provisional Forecasts of Per Capita Demands

Baghdad

Category	Average daily demand (lpcd)	Peak daily demand (lpcd)
Households	160	200
Non-households (See Note 1)	80	88
UfW	80	80
Total	320	368

Other towns

Category	Average daily demand (lpcd)	Peak daily demand (lpcd)
Households	160	200
Non-households (See Note 1)	40	44
UfW	67	67
Total	267	311

Rural communities with piped distribution

Category	Average daily demand (lpcd)	Peak daily demand (lpcd)
Households	120	150
Non-households (See Note 1)	12	13
UfW	44	44
Total	176	207

Note: 1. Specific large industries and residential institutions to be added separately to the overall allowance

Preliminary Demand Forecasts

3.4.7 Preliminary overall estimates of water demand throughout Iraq are presented Tables 3.2 (average daily demand) and 3.3 (Peak daily demand).

3.4.8 These are based on 3% p.a. increase in population and the overall gross per capita demands above.

Table 3-2: Average Daily Water Demands - Preliminary Forecasts for Each Governorate

Governorate	Average Water Demand (m3/d)														
	2005			2010			2015			2020			2025		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Nineveh	429,104	180,183	609,287	497,449	208,882	706,331	576,680	242,151	818,831	668,530	280,719	949,249	775,009	325,431	1,100,440
Al-Tameem	163,446	47,158	210,605	189,479	54,669	244,149	219,658	63,377	283,035	254,644	73,471	328,115	295,202	85,173	380,376
Diala	162,376	150,103	312,479	188,238	174,011	362,249	218,219	201,727	419,946	252,976	233,856	486,832	293,268	271,104	564,372
Al-Anbar	189,943	115,675	305,617	220,195	134,099	354,294	255,267	155,457	410,724	295,924	180,218	476,142	343,057	208,922	551,979
Baghdad	1,895,679	145,509	2,041,187	2,197,611	168,684	2,366,296	2,547,634	195,551	2,743,185	2,953,406	226,698	3,180,104	3,423,807	262,805	3,686,612
Babylon	194,014	142,892	336,906	224,915	165,651	390,566	260,739	192,035	452,773	302,268	222,621	524,888	350,411	258,078	608,489
Kerbela	141,023	49,721	190,745	163,485	57,641	221,125	189,523	66,821	256,345	219,710	77,464	297,174	254,704	89,802	344,506
Wasit	140,146	83,693	223,839	162,468	97,023	259,491	188,345	112,476	300,821	218,343	130,390	348,734	253,120	151,158	404,278
Salah Al-Deen	139,486	110,974	250,459	161,702	128,649	290,351	187,457	149,139	336,596	217,314	172,893	390,207	251,927	200,431	452,357
Al-Najaf	185,636	54,997	240,634	215,203	63,757	278,960	249,480	73,912	323,392	289,216	85,684	374,899	335,280	99,331	434,611
Al-Qadisiya	130,967	78,932	209,899	151,826	91,504	243,330	176,008	106,078	282,087	204,042	122,974	327,016	236,540	142,560	379,101
Al-Muthanna	67,528	56,096	123,625	78,284	65,031	143,315	90,752	75,389	166,141	105,207	87,396	192,603	121,963	101,316	223,280
Thi-Qar	236,158	111,248	347,406	273,772	128,967	402,739	317,377	149,508	466,884	367,926	173,321	541,247	426,528	200,926	627,454
Maysan	136,837	48,094	184,931	158,632	55,754	214,386	183,898	64,634	248,532	213,188	74,928	288,116	247,143	86,862	334,006
Basrah	389,231	69,337	458,568	451,225	80,381	531,606	523,094	93,183	616,277	606,409	108,025	714,434	702,994	125,231	828,225
Duhok	95,596	22,593	118,189	110,822	26,191	137,013	128,473	30,363	158,836	148,935	35,199	184,134	172,656	40,805	213,462
Arbil	292,380	59,629	352,009	338,948	69,126	408,075	392,934	80,136	473,070	455,518	92,900	548,418	528,071	107,696	635,767
Sulaimaniya	332,857	91,590	424,447	385,872	106,178	492,050	447,332	123,089	570,421	518,580	142,694	661,274	601,177	165,422	766,598
Total	5,322,406	1,618,424	6,940,830	6,170,128	1,876,197	8,046,325	7,152,869	2,175,026	9,327,896	8,292,136	2,521,452	10,813,588	9,612,858	2,923,054	12,535,912

Table 3-3: Peak Daily Water Demands - Preliminary Forecasts for Each Governorate

Governorate	Peak Day Water Demand (m3/d)														
	2005			2010			2015			2020			2025		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Nineveh	499,818	211,920	711,737	579,426	245,673	825,099	671,713	284,803	956,516	778,700	330,164	1,108,864	902,726	382,751	1,285,477
Al-Tameem	190,381	55,465	245,846	220,704	64,299	285,003	255,857	74,540	330,397	296,608	86,412	383,020	343,850	100,175	444,025
Diala	189,134	176,542	365,676	219,258	204,661	423,919	254,180	237,258	491,438	294,665	275,047	569,712	341,597	318,855	660,452
Al-Anbar	221,244	136,050	357,293	256,482	157,719	414,201	297,333	182,839	480,173	344,691	211,961	556,652	399,591	245,721	645,312
Baghdad	2,180,031	171,138	2,351,169	2,527,253	198,396	2,725,649	2,929,779	229,995	3,159,774	3,396,417	266,627	3,663,044	3,937,378	309,094	4,246,472
Babylon	225,986	168,060	394,047	261,980	194,828	456,808	303,707	225,859	529,566	352,079	261,832	613,912	408,157	303,535	711,692
Kerbela	164,263	58,479	222,742	190,426	67,793	258,219	220,756	78,591	299,347	255,916	91,108	347,025	296,677	105,620	402,297
Wasit	163,241	98,434	261,675	189,242	114,112	303,353	219,383	132,287	351,670	254,325	153,357	407,682	294,832	177,783	472,615
Salah Al-Deen	162,472	130,520	292,992	188,350	151,309	339,658	218,349	175,408	393,757	253,126	203,346	456,472	293,443	235,734	529,176
Al-Najaf	216,228	64,684	280,912	250,668	74,987	325,655	290,593	86,930	377,523	336,876	100,776	437,652	390,532	116,827	507,359
Al-Qadisiya	152,549	92,835	245,384	176,846	107,621	284,468	205,013	124,763	329,776	237,667	144,634	382,301	275,521	167,670	443,191
Al-Muthanna	78,656	65,977	144,633	91,184	76,485	167,670	105,708	88,668	194,375	122,544	102,790	225,334	142,062	119,162	261,224
Thi-Qar	275,075	130,843	405,918	318,888	151,683	470,570	369,678	175,842	545,520	428,558	203,849	632,407	496,817	236,316	733,133
Maysan	159,387	56,565	215,952	184,773	65,574	250,347	214,203	76,018	290,221	248,320	88,126	336,446	287,871	102,162	390,033
Basrah	453,374	81,550	534,924	525,585	94,539	620,124	609,297	109,596	718,893	706,342	127,052	833,394	818,844	147,288	966,132
Duhouk	111,349	26,572	137,922	129,084	30,805	159,889	149,644	35,711	185,355	173,479	41,399	214,877	201,109	47,993	249,102
Arbil	340,562	70,132	410,694	394,805	81,302	476,107	457,687	94,251	551,938	530,585	109,263	639,848	615,094	126,665	741,759
Sulaimaniya	387,710	107,722	495,432	449,462	124,880	574,342	521,050	144,770	665,819	604,039	167,828	771,867	700,247	194,558	894,805
Total	6,171,462	1,903,487	8,074,950	7,154,416	2,206,663	9,361,080	8,293,929	2,558,128	10,852,057	9,614,937	2,965,571	12,580,508	11,146,347	3,437,910	14,584,257

4 Water Balances

- 4.1.1 An assessment of water demands and the methods of disposal of wastewater enables a water balance for the potable and industrial water supplies for each district to be prepared. This water balance will show transfers from one part of the river system to another and also movements between surface water and groundwater. An example for Thi Qar governorate is given in Figure 4-1.
- 4.1.2 In the diagram for Thi Qar, water for the towns is known to come mostly from the major rivers. Assumptions have had to be made about the sources of water for rural areas, in particular the volume taken from groundwater and from canals.
- 4.1.3 Water for Nasariyah is transferred from the Gharaff River, which has relatively good quality water, but the wastewater is returned to the Euphrates or to groundwater from septic tank soakaways. Assumptions have been made about the number of people and institutions disposing of wastewater either to the sewerage system, open drains or septic tanks with soakaways. The sewerage system and the open drains are assumed to deliver wastewater to the river.
- 4.1.4 For other towns, it is assumed that more water will be transferred from the Gharaff River in the future, but wastewater will be returned after treatment to the River Euphrates.
- 4.1.5 A similar diagram for Erbil Governorate is given in Figure 4-2. Data on the water demands and wastewater generation for Erbil city were not available and are omitted from the diagram.

Figure 4-1: Preliminary Water Balance for Thi Qar Governorate

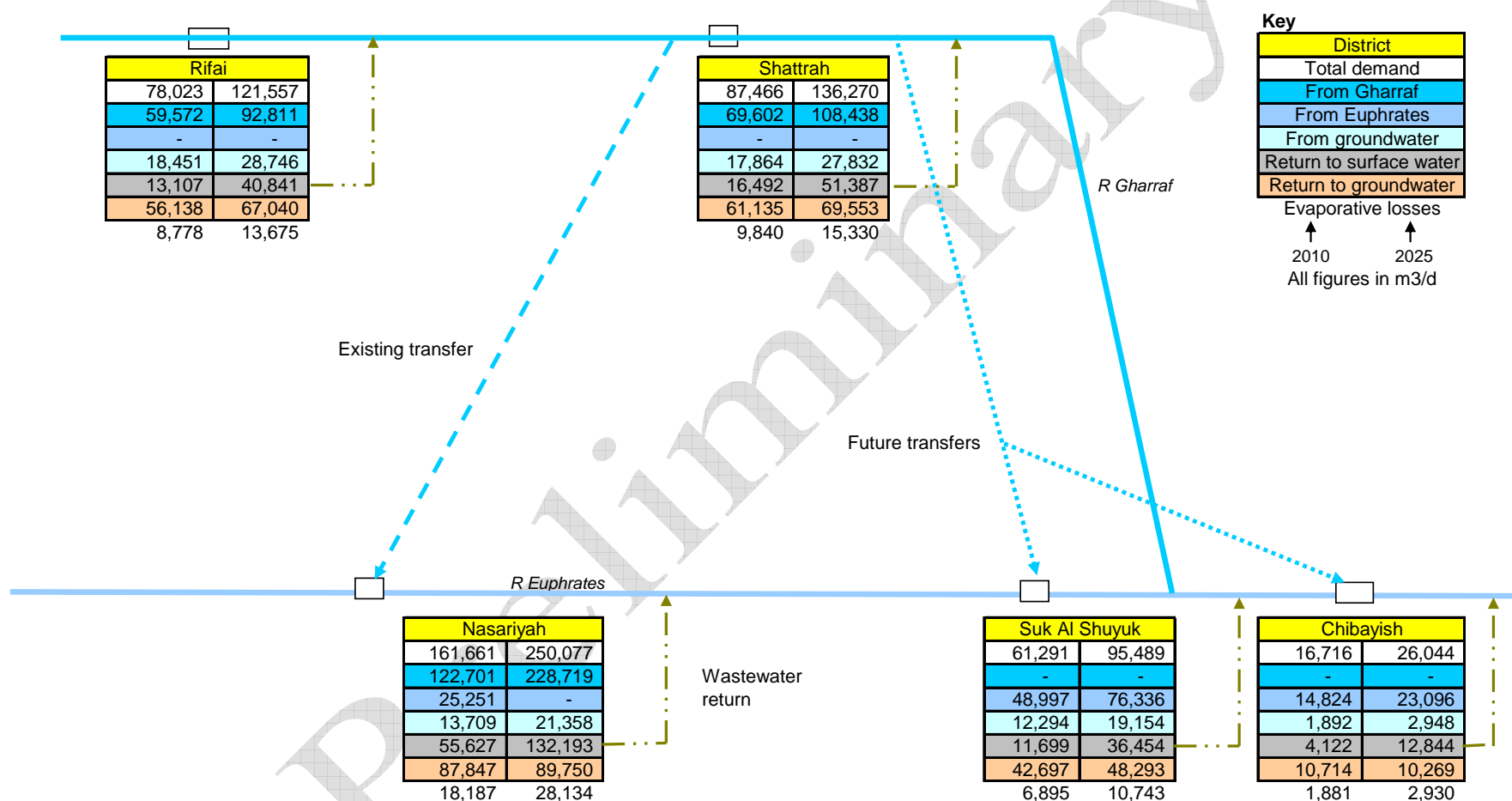
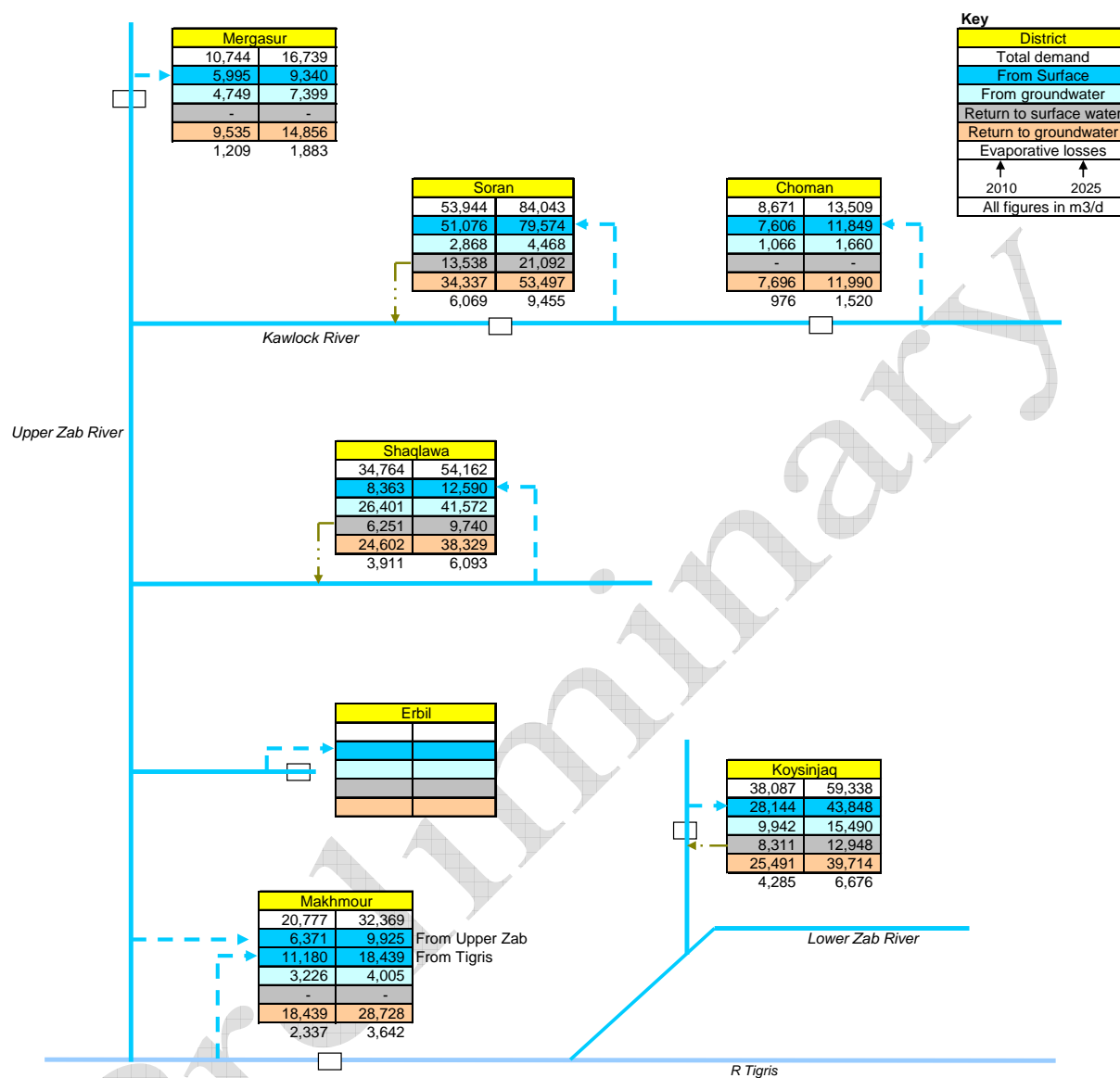


Figure 4-2: Preliminary Water Balance for Erbil Governorate



5 Investment Planning

5.1.1 The provision of an investment plan for potable water supplies is beyond the scope of this study. However, it is intended in this section to provide an overall view on the following:

- The capacity of water sources and water treatment works required in comparison with existing works. This would include conventional works and compact units.
- The additional resource capacity required to 2025, with indications of probable source (surface water, groundwater, seawater desalination).
- New treatment capacity, including replacement of compact units.
- Indicative extent of new distribution networks and numbers of additional consumer connections.
- The requirements for leakage control.
- Indicative extent of new sewerage systems and numbers of additional consumer connections.

5.1.2 The extent of works required will be determined on the basis of the demand forecasts in Section 3 above.

5.1.3 An outline of the approach to determining the investments needed was to be included in a brief guidance note.

5.1.4 This section and the associated Guidance Note have not been written.